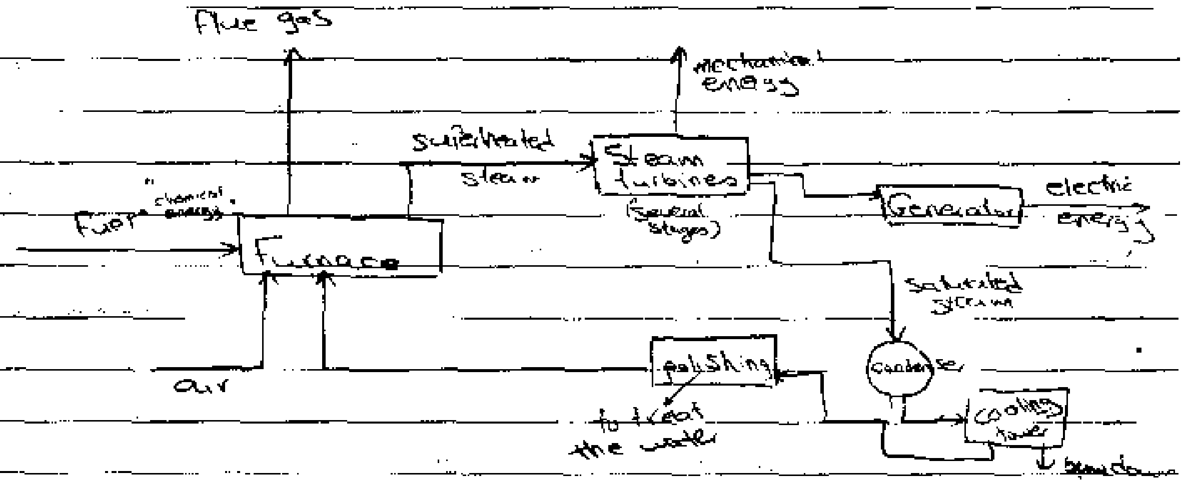
Date: 4-5-2008

lecture 9



* Source of heat losses in furnace

i) heat losses in stack gases ii) heat losses in blow down

iii) heat losses from the furnace itself (according to degree of insulation)

* Steam turbines

- According to the 2nd law of thermodynamics, we cant convert heat energy to mechanical energy without having (heat sink). So, we're limited with something similar to carnot cycle efficiency (Brayton cycle).

heat rejected

theoretical

- carnot cycle) $\eta = \frac{T_2 - T_1}{T_2}$ → T_1 heat sink, T_2 heat source

T_2 : temp. of superheated steam, T_1 : temp. of ambient blow down

ex) * The source of losses in furnace

heating excess air = 0.2 %

incomplete fuel combustion = 0.8 %

heating moisture in coal = 5 %

(Note : liquid & solid fuels mainly have moisture content)

energy in the flue gases = 5 %

acc. to degree of insulation

heat losses from the furnace itself = 0.5 %

*Heat rejected to cooling tower = 50.4 %

(This's fn. in Carnot cycle η. As $T_2 \uparrow$, Carnot cycle efficiency $\uparrow$ ⇒ but we've limits for the temp. because of the material of construction).

* Auxiliary equipments losses = 1.5 %

⇓

FGD system

(ex: flue gas desulphurization system which follow the economizer ⇒ This can be performed by lime treatment ($Ca(OH)_2$) ⇒ so, there is heat losses in this process. But, the flue gases will cool down, and so we need more energy to push the gases out in the stack.

as the flue gases must go out with certain momentum

* feed preparation = 0.45 %

N.G compressing — coal pulverizing

* Pumps and fans in cooling towers = 0.8 %

* electrostatic precipitators = 0.8 % ⇒ To remove ash

consumes high power energy

[So, by multiplying all the above efficiencies, the overall η will be about 35 %]

Notes

mainly used in ships — high carnot cycle η

- gas turbines are the turbines operating by the hot flue gases (but it's not practical because of the high cost of mat. of construction and the occurrence of hot corrosion which is very severe Ex: Alloy forms a molten layer on the surface

* Comparison between the different energy sources

Traditional	Fuel cells	Photovoltaic cells
* Actual η from 30 - 40 %	* Actual η can't exceed 60 - 65 %	* Actual η can't exceed 12 %
* Several types of fuels can be used as fuel source (N.G, fuel oil, coal)	* H_2 is the most practically used fuel (can be considered renewable). CH_4 can be used as a fuel if high temp fuel cells are more developed	* Solar energy is the energy source
* For the same powerplant capacity, it's the cheapest w.r.t capital investment (the cost of 1 KW)	* About 10 times the cost of traditional power plants (because of electrocatalysts, bipolar materials)	* About 35 times the cost of traditional power plants from (30 - 40 times)
* Has the most severe environmental impact (low incre of using NG method) i) air emissions "NO_x, SO_x" ii) ash "particulates mainly in coal" iii) wastewater from blowdown iv) noise pollution : about 100 decibel	- noiseless as there is no moving parts - No local effect emissions (NO_x, SO_x, ...) - But, the global effect is considerable if CO_2 is formed	- noiseless as there is no moving parts - Clean energy
* low flexibility where if the capacity ↑ or ↓, the η will decrease → like the flame in the burner burning	* high flexibility "modular structure"	high flexibility "modular structure"

- low flexibility limits is that the capacity must be always constant - so, load leveling is needed where the excess energy produced is stored in batteries to be used on need		
* AC is produced which is an advantage	* Dc is produced	* Dc is produced